VON LEHMANN, E. & SÄGESSER, H. (1986): *Capreolus capreolus* Linnaeus, 1758 – Reh. Pp. 233–268 in NIETHAMMER, J. & KRAPP, F. (eds.): Handbuch der Säugetiere Europas. Band 2/II. Artiodactyla. Aula Verlag, Wiesbaden.

VUJOŠEVIĆ, M. & BLAGOJEVIĆ, J. (1997): Y chromosome polymorphism in the bank vole *Clethrionomys glareolus* (Rodentia, Mammalia). Zeitschrift für Säugetierkunde **62**: 53–57.

WILSON, D. E. & REEDER, D. A. M. (1993): Mammal species of the World. A taxonomic and geographic reference. Smithsonian Institution Press, Washington.

ZIMA, J., MACHOLÁN, M., FILIPPUCCI, M. G., REITER, A., ANDREAS, M., LÍPA, M. & KRYŠTUFEK, B. (1994): Karyotypic and biochemical status of certain marginal populations of *Sorex araneus*. Folia Zoologica suppl. **43**: 43–51.

ZIMA, J., FEDYK, S., FREDGA, K., HAUSSER, J., MISHTA, A., Searle, J. B., VOLOBOUEV, V. T. & WÓJCIK, J. M. (1996): The list of the chromosome races of the common shrew (*Sorex araneus*). Hereditas **125**: 97–107.

ZIMA, J., MACHOLÁN, M., KRYŠTUFEK, B. & PETKOVSKI, S. (1997): Karyotypes of certain small mammals (Insectivora, Rodentia) from Macedonia. Scopolia **38**: 1–15.

ZIMMERMANN, K. (1962): Nachruf auf W. E. MARTINO. Zeitschrift für Säugetierkunde **27**: 251–252.

ŽIVKOVIĆ, S. & PETROV, B. (1975): The karyotype of *Microtus guentheri* Danford et Alston, 1880, from Yugoslavia and the taxonomic status of that vole (Mammalia, Rodentia). Arhiv bioloških nauka **27**: 15P–16P.

ŽIVKOVIĆ, S., PETROV, B. & RIMSA, D. (1975b): New data on the taxonomy of Balkan *Pitymys* representatives (Mammalia, Rodentia) in the light of karyological analysis. Biosistematika **1**: 31-42 [In Serbian with English summary].

ŽIVKOVIĆ, S., RIMSA, D., RUŽIĆ, A. & PETROV, B. (1975a): Cytogenetical characteristics, taxonomic status and distribution of the voles with 46 and 54 chromosomes of the *Microtus arvalis* group in Yugoslavia (Rodentia, Mammalia). Arhiv bioloških nauka **26**: 123-134.

Authors' addresses: Boris KRYŠTUFEK (corresponding author), Slovenian Museum of Natural History, P.O. Box 290, SI-1001 Ljubljana, Slovenia, e-mail: boris.krystufek@uni-lj.si; Svetozar PETKOVSKI, Macedonian Museum of Natural History, Bul. Ilinden 86, 91000 Skopje, Republic of Macedonia.

Received: 03.06.2000
Accepted: 24.08.2000
Revised: 04.09.2000
Corresponding editor: G. PETERS

Bonner zoologische Beiträge	Band 51 (2002)	Heft 4	Seiten 255–260	Bonn, Dezember 2003

Experimental, Morphological and Ecological Approach to the Taxonomy of Oriental *Lema* Species (Insecta: Coleoptera: Chrysomelidae)

T. Kalaichelvan [1], Krishna K. Verma [2] & Bhupendra N. Sharma [3]

[1] Maitri Bagh Zoo, Bhilai Steel Plant, Bhilai (Chhattisgarh), India
[2] Retired Professor of Zoology, M. P. Govt. P. G. Colleges, Durg (Chhattisgarh) India
[3] Govt. Arts & Science College, Vaishalinagar (Dist. Durg) (Chhattisgarh), India

Abstract. On basis of breeding experiments, aedeagal structure, ecological preferences and feeding pattern *Lema coromandeliana, L. praeusta, L. terminata and L. maheensis* have been synonymised, and given the species name *L. praeusta.* On a similar basis *L. tibiella* and *L. semifulva* have been synonymised and put under species *L. semifulva.* A hypothesis is proposed to account for polymorphism among widely distributed species.

Key words. *Lema coromandeliana, L. praeusta, L. terminata, L. maheensis, L. tibiella, L. semifulva,* breeding, aedeagus, ecology, feeding pattern.

1. INTRODUCTION

Jacoby (1908), in his volume on Criocerinae and some other chrysomelid subfamilies of the Indian subcontinent, expressed doubt as to validity of some species of *Lema*. Describing '*Lema coromandeliana* Fabr.' he said, "The correct synonymy of this is not at all understood at present". Under description of '*L. praeusta* Fabr.' he pointed out, "It is quite possible that this (= *L. praeusta*) and the following species (= *L. terminata* Lacord.) may be only varieties of *L. coromandeliana*, as they seem to differ solely in coloration". Some observations, made by us in 1997 and 1998, on *Lema* populations of Durg–Bhilai (India), suggested the need to synonymise *L. coromandeliana* and some closely allied species of *Lema*. Hence in 1999, when *L. coromandeliana* and some other species of *Lema* appeared in good numbers in July in Durg–Bhilai, some breeding experiments were arranged, and observations were made on aedeagal structure, ecological preferences and feeding pattern. Results of these studies are presented here.

2. MATERIAL AND METHODS

2.1. Identification of Material

In 1974, E.A.J. Duffy of Commonwealth Institute of Entomology (CIE), London, identified a criocerine material from Durg as *Lema coromandeliana* {CIE List No. 6050 (Asia)}. This identification and the description by Jacoby (1908) for *L. coromandeliana* and for other Indian species of *Lema* have been the basis for identification of material for the present project. Main features of the six species, studied, are:

Lema coromandeliana (Fabricius, 1798): Various features as mentioned by Jacoby (1908). But the material, identified by Duffy, as well as most of the material, studied in the present context, have fulvous legs and antennae. Though Jacoby (1908) mentions legs, antennae and sides of the breast in this species as greenish black, he points out also that specimens from Calcutta and other parts of India, examined by him, had fulvous antennae and legs. Verma (1994) has discussed this variant of *L. coromandeliana*. In course of the present study we have come across individuals with black antennae and legs too (vide infra), though generally *L. coromandeliana* in this area (Durg–Bhilai) have fulvous appendages.

Lema tibiella Weise, 1903: Similar to *L. coromandeliana,* but legs, antennae, thorax and abdominal venter are black. Another characterstic – a conical tibial tooth on the middle tibia before/proximal to the middle of the length of the tibia. It seems that such a tibial tooth is not always present. Out of 7 individuals, examined, such structure was seen only in 5.

Lema praeusta (Fabricius, 1792): Apical third of the elytra bluish black, the rest fulvous. Antennae and legs fulvous. Sides of the breast black. On the prothorax the posterior transverse sulcus is deep, but the anterior sulcus is feeble.

Lema terminata Lacordaire, 1845: Similar to *L. praeusta*, but antennae and legs black.

Lema semifulva Jacoby, 1889: Sides of the elytra fulvous, the fulvous area in the form of a longitudinal band narrowing posteriorly. Sides of the breast, antennae and legs black. The prothorax shows, in addition a deep transverse sulcus near the basal margin, a shallow transverse anterior sulcus.

Lema maheensis Jacoby, 1908: Similar to *L. coromandeliana*. But elytra are entirely fulvous. Sides of the breast and apical part of the head black.

In all the six species the apical part of the head is black, breast is black, atleast on sides and the prothorax shows two transverse sulci, though the anterior sulcus may be feeble and medially interrupted.

2.2. Availability of material

In 1999 from July to September the six species, mentioned in the previous section, were available on *Commelina*

Table. 1. Results of breeding experiments with the six *Lema*-"species" under investigation in different combinations.

Experiment no.	Cross	Progeny					
		L. co.	*L. pr.*	*L. te.*	L. mahe´	*L. ti.*	*L. se.*
1a	*L. co.* ♂ x *L. co.* ♀	7 (2 ♂, 5 ♀)	3 (♂, 2 ♀)	0	1 ♂	0	0
1b	*L. co.* x *L. co.* (from progeny of Breeding expt. 1a)	9 (5 ♂, 4 ♀) + 1 ♀ with black antennae and legs	2 (1 ♂, 1 ♀)	0	3 ♂	0	0
1c	*L. pr.* x *L. pr.* (from progeny of expt. 1a)	2	1	0	0	0	0
2	*L. co.* x *L. co.*	6 (N. B.: in the next generation too only *L. co.*).	0	0	0	0	0
3	*L. co.* (a bunch of individuals)	17 (2 ♂, 15 ♀)	7 (3 ♂, 4 ♀)	0	0	0	0
4	*L. co.* x *L. co.*	22 (9 ♂, 13 ♀) + 1 ♀ with black antennae & legs	0	0	0	0	0
5a	*L. pr.* x *L. pr.*	4 (1 ♂, 3 ♀) + 1 ♀ with black antennae & legs	8 (3 ♂, 5 ♀)	2 (1 ♂, 1 ♀)	1 ♂	0	0
5b	*L. pr.* x *L. pr.* (from progeny of expt. 5a)	1 (1 ♀)	2 (1 ♂, 1 ♀)	1 ♂	0	0	0
5c	*L. te.* x *L. te.* (from progeny of expt. 5a)	0	0	10 (sex was not determined)	0	0	0
6a	*L. pr.* x *L. pr.*	3 (2 ♂, 1 ♀)	18 (8 ♂, 10 ♀)	1 ♀	0	0	0
6b	*L. pr.* x *L. pr.* (from progeny of expt. 6a)	1	2	0	0	0	0
7	*L. pr.* x *L. pr.*	0	1 ♀	0	0	0	0
8a	*L. te.* x *L. te.*	6, all with black legs & antennae (2 ♂, 4 ♀)	2 (1 ♂, 1 ♀)	8 (3 ♂, 5 ♀)	0	0	0
8b	*L. te.* x *L. te.* (from progeny of expt. 8a)	1 (sex?)	1 (sex?)	2 (sex?)	0	0	0
9	*L. ma.* x *L. ma.*	1 ♀	0	0	3 (1 ♂, 2 ♀)	0	0
10	*L. ma.* x *L. ma.*	0	0	0	3 (1 ♂, 2 ♀)	0	0
11a	*L. ti.* x *L. ti.*	0	0	0	0	3 (sex?)	0
11b	*L. ti.* x *L. ti.*	0	0	0	0	8 (sex?)	0
12	*L. ti.* x *L. ti.*	0	0	0	0	7 (sex?)	4 (sex?)
13	*L. ti.* x *L. ti.*	0	0	0	0	3 (sex?)	2 (sex?)
14a	*L. se.* x *L. se.*	0	0	0	0	3 (1 ♂, 2 ♀)	5 (1 ♂, 4 ♀)
14b	*L. ti.* x *L. ti.* (from progeny of 14a)	0	0	0	0	17 (14 ♂, 3 ♀)	2 ♂
14c	*L. ti.* x *L. ti.* (from progeny of 14b)	Development could occur only upto pupae, which died out.					
15a	*L. se.* x *L. se.*	0	0	0	0	14 (6 ♂, 8 ♀)	4 (2 ♂, 2 ♀)
15b	*L. se.* x *L. se.* (from progeny of expt. 15a)	0	0	0	0	0	2 ♂
15c	*L. ti.* x *L. ti.* (from progeny of expt. 15a)	0	0	0	0	8 (5 ♂, 3 ♀)	5 (3 ♂, 2 ♀)
15d	*L. se.* x *L. se.* progeny of 15c)	0	0	0	0	1 ♂	2 ♂
15e	*L. ti.* x *L. ti.* (from progeny of 15c)	0	0	0	0	6 (3 ♂, 3 ♀)	1 ♂
16a	*L. se.* x *L. se.*	0	0	0	0	7 (2 ♂, 5 ♀)	16 (8 ♂, 8 ♀)
16b	*L. ti.* x *L. ti.* (from progeny of 16a; only one pair taken)	Only 2 pupae formed; got damaged by parasites.					
16c	*L. se.* x *L. se.* (from progeny of 16a)	0	0	0	0	0	3 (sex?)
17a	*L. se.* x *L. se.*	0	0	0	0	12 (5 ♂, 7 ♀)	23 (13 ♂, 10 ♀) In addition 4 individuals with pronotum, elytra, venter, legs and antennae all black; sp.?
17b	*L. se.* x *L. se.* (from progeny of 17a; only one pair taken)	0	0	0	0	0	1
18	*L. ti.* ♂ x *L. se.* ♀	0	0	0	0	0	3 (1 ♂, 2 ♀)
19	*L. ti.* ♂ x *L. se.* ♀	0	0	0	0	4 (2 ♂, 2 ♀)	3 (1 ♂, 2 ♀)
20	*L. se.* ♂ x *L. ti.* ♀	0	0	0	0	3 (2 ♂, 1 ♀)	3 (1♂, 2 ♀)
21	*L. se.* ♂ x *L. se.* ♀	0	0	0	0	0	8 (sex?)

N. B.: (1) *L. co.* = *Lema coromandeliana;* (2) *L. ma.* = *Lema maheensis;* (3) *L. pr.* = *Lema praeusta;* (4) *L. te.* = *Lema terminata;* (5) *L. ti.* = *Lema tibiella;* (6) *L. se.* = *Lema semifulva*

weeds in the Sector 8 Park and elsewhere in Durg – Bhilai. They have been collected and maintained in plastic jars on *Commelina* leaves. Both field collected as well as culture individuals have been studied.

2.3. Breeding experiments

For breeding experiments field collected males and females of the same or different species have been kept in culture jars. When the next generation, produced by these males and females, reached the adult stage, the progeny was examined for species status. When interpreting results of these experiments, this possibility was kept in view that the field collected female might be mated before transfer into the culture. When, for maintaining these cultures leaves were periodically changed, care was taken to thoroughly clean the fresh leaves and to make sure that no eggs were present on them.

2.4. Aedeagus examination.

After separating the abdomen of a spirit preserved male from the rest of the body, sides of the abdomen were cut, and its tergal and sternal wall were separated to remove the aedeagus, which, after leaving in 5% KOH solution for 24 hours, was dehydrated, cleared and mounted, examined and measured using an oculometer scale.

3. OBSERVATIONS

3.1. Interspecific copulation

We have looked for "interspecific" copulations, if any, both in the field as well as in cultures. The only such copulations, we could observe, have been ♂ *L. tibiella* x ♀ *L. semifulva* and ♂ *L. semifulva* x ♀ *L. tibiella*, which could be seen several times.

3.2. Breeding experiments

Results of these experiments are shown in Table 1.

One obvious inference from these crosses is that there are two groups or complexes among the six "species"; one includes *L. coromandeliana*, *L. praeusta*, *L terminata*, and *L. maheensis*, and the other is made up *L. tibiella* and *L. semifulva*. In either complex "intraspecific"/"intracomplex" crosses may yield, among the progeny, members of other "species" included in the complex. Let us henceforth refer to the two complexes as the *L. coromandeliana* complex and the *L. semifulva* complex.

3.3. Aedeagi

Aedeagi of all the six species have been examined. They have been found to be of similar construction, which is seen also in other Criocerinae (WHITE 1993). A typical criocerine aedeagus is a long sclerotic tube, bent on its ventral face, the bend being more marked in the basal part. The basal orifice is large and ventrally directed. The ostium, on the other hand, is dorsally placed in the distal portion.

According to WHITE (1993) aedeagi of *Lema* are not quite helpful in distinguishing closely related species. But in the present study notable differences could be made out between the aedeagi of *L. coromandeliana* complex and *L. semifulva* complex. Within either complex the aedeagi are remarkably uniform in their features. The aedeagal differences between the two complexes:

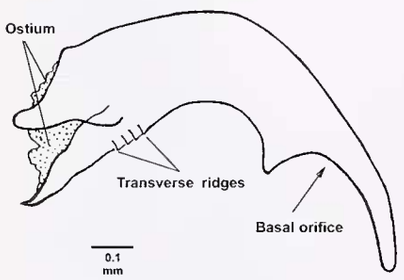
(a) 18 aedeagi of the *L. coromandeliana* complex and 15 of *L. semifulva* complex have been measured for their length from base to the tip, ignoring the ventral curvature. This measurement ($\bar{x} \pm$ s.e.) for the *L. coromandeliana* group: 1.215 ± 0.129 mm, and for the *L. semifulva* group: 1.530 ± 0.065 mm. Thus in the latter group the aedeagus is a little longer than in the former.

In the *L. semifulva* complex the tube of the aedeagus, beyond the basal well marked bend, is a little longer than in the other complex (Figs. 1 and 2).

The aedeagus in the *L. coromandeliana* complex presents 4 to 6 transverse ridges on the ventral face of its distal half. The corresponding organ in the other group does not have such ridges (Figs. 1, 2, 3 and 4).

The tip of the aedeagus is bent upward in the *L. coromandeliana* group, and it is bent downward in the other complex (Figs. 1, 2, 3 and 4).

Thus the aedeagal structure supports the making out of the two clusters or complexes among the six species of *Lema* on basis of results of the breeding experiments.



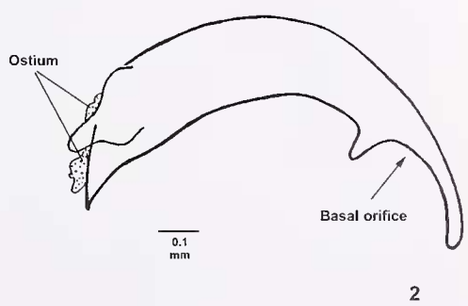


Fig. 1: *L. terminata*, out-line of aedeagus.

Fig. 2:*L. semifulva*, out-line of aedeagus.

3.4. Ecological preferences

The six species of *Lema* have been collected from the weed *Commelina*. In the Sector 8 Park of the Bhilai Township there are two species of *Commelina*, a species with narrow lanceolate leaves, growing along marshy edges of a pond (Fig. 6) and the other with broad leaves, growing in drier situations around the pond (Fig. 5). Members of the *L. semifulva* complex were specially numerous on the narrow leaf *Commelina* species, and those of the *L. coromandeliana* complex on the broad leaf species of the weed. But either complex is not confined to its preferred zone as described above.

3.5. Feeding pattern

Only a small difference has been noted in the feeding pattern of the two complexes of *Lema* species (Figs. 7, 8, 9 and 10). In the *L. semifulva* complex the eaten away areas in leaves tend to be more longish and more marginal in location, and often they leave a thin marginal thread in the leaf (indicated by arrows in Figs. 7 and 8).

4. DISCUSSION

Results of the breeding experiments clearly suggest conspecificity of *L. coromandeliana*, *L. praensta*, L. *terminata* and of *L. maheensis* on one hand, and of *L. semifulva* and *L. tibiella* on the other. That members of either of the two complexes be synonymised is supported by the aedeagal structure, ecological preferences and feeding pattern of the "species", included in the two complexes.

Considerable synonymisation of *L. coromandeliana* and related species has been done earlier. SCHMITT (1988) has indicated synonymy of *L. coromandeliana* and *L. praensta*. In personal communication, dated 18th Nov. 1999, Michael SCHMITT has informed that Francisco MONRÓS in 1959 (published in 1960) took decision to synonymise the following species: *L. coromandeliana* Fabricius, *L. allardi* Baly, *L. binghami* Jacoby, *L. bretinghami* Baly, *L. philippina* Weise, *L. cyanipennis* Olivier, *L. rufipes* Weise, *L. dichroa* Blanchard, *L. gangetica* Weise, *L. melanocera* Lacordaire, *L. melanura* Fabricius, *L. obscuriventris* Pic, and *L. praensta* Fabricius. In this group of "species" names, that of *L. coromandeliana* was treated as the oldest by MONRÓS as per SCHMITT.

In view of the observations, pointed out in the first para. under the current "Discussion", it has been decided to regard the two "species" complexes of *Lema* as two species. That is *L. coromandeliana*, *L. praensta*, *L. terminata* and *L. maheensis* be synonymised, and the resultant species be called *L. praensta* which name was given in 1792, and is thus the oldest available name. Similarly *L. semifulva* and *L. tibiella* be synonymised, and the species, including the two, be called *L. semifulva*, which is older among the two names.

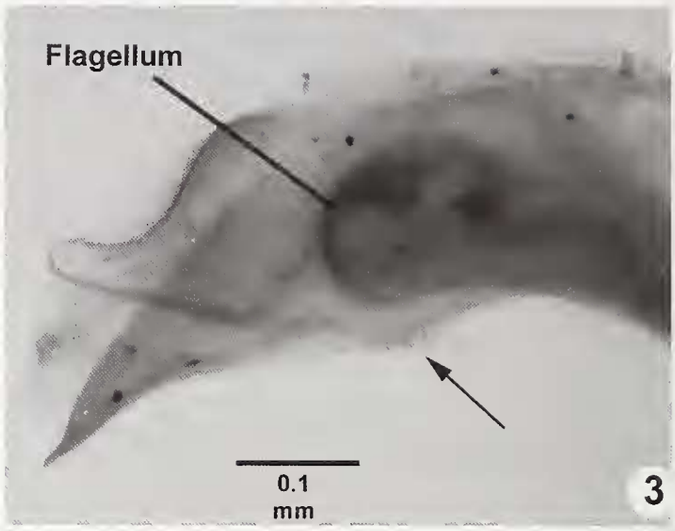


Fig. 3: *L. terminata*, photomicrograph of apical part of aedeagus (The arrow points to transverse ridges, which are somewhat out of focus).

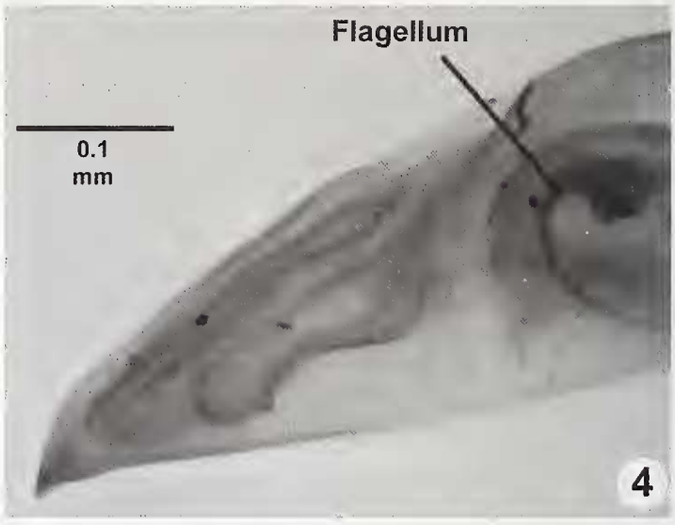


Fig. 4 *L. tibiella*, photomicrograph of apical part of aedeagus.

Lema praensta (under *Crioceris*), FABRICIUS (1792, part 2, p.8, no. 25). LACORDAIRE (1845, p.340).
Lema coromandeliana (under *Leptura*), FABRICIUS (1798, p.154). LACORDAIRE (1845, p.377.
Lema terminata, LACORDAIRE (1845, p. 341)
Lema maheensis, JACOBY (1908, p. 39).

Lema semifulva JACOBY (1889, p:152).
Lema tibiella, WEISE (1903, p.20).

The "species", synonymised in this communication, may be referred to as varieties or phena. For example, *L. tibiella* may be taken as a variety or phenon of